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Muscle strength in patients with chronic pain

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Objective: To analyse the influence of chronic pain on muscle strength.

Design: Muscle strength of patients with unilateral nonspecific chronic pain, in an upper or lower limb, were measured according to a standardized protocol using a hand-held dynamometer. Before and after muscle strength measurement, a visual analogue scale for pain intensity was assessed.

Results: Forty patients were measured and the muscle strength of the painful side was 20–30% less than that of the nonpainful side. Strength reduction was seen in the whole limb. A significant correlation between pain intensity and reduced muscle strength in the painful limb existed for hip flexion, knee flexion, knee extension and three-point grip.

Conclusions: A strength reduction of 20–30% in a painful limb seems to be 'normal' in chronic pain patients.

Introduction

Muscle strength measurement is a diagnostic procedure commonly performed in the assessment of patients with presumed neurological deficits and for rehabilitation outcomes.¹ The most commonly used method to evaluate muscle strength clinically is the manual muscle test of the Medical Research Council (MRC).² In the last decade dynamometry to measure muscle strength has been used increasingly. Several methods of dynamometry are available. A frequently used method is hand-held dynamometry. It offers an easy to use and direct approach for muscle strength measurement.³ The reliability of muscle strength measurement depends on which muscle

is tested,^{4,5} the choice of the test modes,² and standardization of the test procedure. The percentage of variation in muscle strength in healthy persons can be attributed to the subject (78.9–85.7%), observer (1.9–3.8%), day (1.1–8.7%), interaction observer/day (1.2–4.8%), and the interaction subject/day (7.9%–9.2%).³ In patients with long existing complex regional pain syndrome type I the percentage of variation in grip strength can be attributed to the patients (83.8%), the observer (2.9%), the session (0.3%), the interaction between patient and observer (1.9%), and interaction between patient and session and observer (3.9%).⁶ Because muscle strength measurement demands an active participation of the patient, the variation attributed to the patient is high. Clinically this variation seems even higher when pain is involved.

Some investigators have analysed the influence of pain on muscle strength. In a group of 25 patients with patellar tendinitis pain, quadriceps

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muscle strength was measured with a Cybex II test using peak torque values. Pain was significantly and negatively correlated with quadriceps muscle strength; in 30° knee flexion $r = -0.59$, in 180° knee flexion $r = -0.40$. The duration of pain was not reported in this study.⁷ In a group of 23 patients with unilateral knee dysfunction, it was demonstrated that a significant difference existed between painful and nonpainful limbs in quadriceps peak strength, ranging from 11% to 18%. Again the duration of pain was not reported.² In a group of 65 patients with chronic complex regional pain syndrome type I (mean duration of pain 5.7 years), full-fist, three-point grip and pinch grip was measured by hand-held dynamometry. The painful side was compared with the nonpainful side and it appeared that grip strength was reduced 20–30% in the painful side. In a study of 45 patients with pain (mean duration eight months) due to tennis elbow, Pienimäki *et al.* described a mean loss of 14% in grip strength.⁸

In the above mentioned studies muscle strength and pain seem to be inversely related. Muscle strength in these studies was measured in one muscle group in patients with specific diagnoses. The aim of this study was to analyse the influence of chronic pain on muscle strength in limbs with nonspecific chronic pain, and to analyse the influence of pain intensity and pain duration.

Methods

The study was performed in the Pain Centre of the University Hospital in Groningen. All patients were visiting the Pain Centre for the first time. Before admission to the study the medical correspondence as well as a questionnaire filled out by the patient, including social data, pain history, and anatomic pain drawings, were analysed. Inclusion criteria for this study were:

- Chronic pain for at least six months without evidence of nociception.
- Age between 20 and 65 years.
- One painful side (upper limb or lower limb) and one nonpainful side (upper limb or lower limb).

Patients were excluded if pain was caused by cancer, if patients had psychiatric disorders,

neurological or neuromuscular diseases, complex regional pain syndrome type I or if patients were not able to understand Dutch. All patients eligible for the study were informed about the study and asked by the physician to participate in the study. If a patient was willing to participate, their muscle strength was measured according to a standardized protocol (Table 1) using a hand-held dynamometer (Microfet). Shoulder abduction, elbow extension and three-point grip were measured in patients with a painful upper limb, or hip flexion, knee flexion and knee extension were measured in patients with a painful lower limb. All measurements were performed bilaterally. Before testing, a warm-up session was performed. Patients were asked to produce a maximal muscle contraction; 2 seconds to build up maximum strength, and 4–5 seconds to keep this maximum. During a contraction patients were verbally encouraged twice. Each motion was measured three times, with a 20-second rest period between the measurements. The mean of the three measurements was used for further statistical analyses.

Directly before and after the three muscle strength measurements patients were asked to fill out a non-numbered visual analogue scale (VAS) ranging from no pain (0) to worst pain ever (10). All measurements were performed by two trained physical therapists. All measurements of on one patient were performed by the same physical therapist.

All statistical analyses were carried out using SPSS version 10.0, including Student's *t*-test for paired sample, and calculation of Pearson's *R* correlation coefficient. The relation between pain intensity and muscle strength was analysed by correlating the difference in muscle strength between painful and nonpainful sides with the VAS pain before testing.

Results

Forty patients were measured, of whom 27 had pain unilaterally in a lower limb (mean VAS 3.6, SD 2.9), and 13 had pain unilaterally in an upper limb (mean VAS 4.0, SD 2.5). Thirteen were male, mean age 46 years (SD 9) and 27 female, mean age 42 years (SD 14). The intensity of pain

was significantly ($p < 0.05$) higher for female patients (VAS 4.2, SD 2.8) compared with male patients (VAS 2.6, SD 2.0). All patients were diagnosed with nonspecific chronic pain. The mean duration of pain was 74 months (median 39, min 6, max 502). The mean VAS before testing was 3.7 (SD 2.6).

The mean scores for muscle strength on the painful side were significantly lower than those on the nonpainful side, except for grip strength (Table 2). Muscle strength on the painful side was about 20–30% less than that on the nonpainful side (Table 2).

This reduction in muscle strength of a painful limb was significantly correlated, except between three-point grip and shoulder abduction (Table 3).

A significant correlation between pain intensity and the differences in muscle strength existed for hip flexion, knee flexion, knee extension and three-point grip (Table 4). Duration of pain was not related to differences in muscle strength (Table 4). VAS scores increased significantly after muscle testing. The mean VAS after muscle testing was 5.7 (SD 2.5) ($p < 0.001$).

Discussion

Chronic pain is significantly related to a reduction of muscle strength of 20–30% in the painful limb. A significant relation between pain intensity and reduced muscle strength was found for

most muscle groups. No relation was found between duration of pain and strength reduction. The correlations between the muscle strength of painful limbs indicate that loss of muscle strength is not restricted to one muscle group but seems to affect the whole limb. Strength reduction in a whole limb might be specific for patients with long-term nonspecific chronic pain.

Our outcomes are in agreement with the findings of Geertzen *et al.* who described a similar reduction, in a group of patients with long-term complex regional pain syndrome type I.⁶ The 20–30% strength reduction is a higher percentage than the 11–18% described by Reinking *et al.*,² and the 14% described by Pienimäki *et al.*⁸ Reasons for this difference might be that in the study of Reinking *et al.* the group had a shorter history of pain or a lower intensity of pain, but these data are lacking. The group described by Pienimäki *et al.* had a shorter history of pain but pain intensity was similar to that in our group. Furthermore both groups had a specific diagnosis, in contrast to our group of patients, in which the chronic pain was nonspecific.

Several reasons for muscle strength reduction in chronic pain patients can be hypothesized. Strength reduction may be related to behavioural (psychological) and/or physical factors. Motivation for physical assessment in patients with chronic pain may be less because of experiences in previous assessments in which maximal contraction was requested. Patients might fear maximal contraction because of the expected increase

Table 1 Muscle test protocol

Muscle group	Subject position	Hand-held dynamometer position
Upper limb muscle groups		
Shoulder abduction	Sitting upright, shoulder 90° abducted, elbow 135° flexed, forearm pronated	Lateral epicondyle of humerus
Elbow extension	Supine, shoulder adducted, elbow 90° flexed, fore upper limb supinated	Just proximal to wrist crease
Three-point grip	Sitting forearm pronated, wrist extended	Distal phalanx of thumb under dynamometer, distal two phalanges of dig 2 and 3 upon dynamometer
Lower limb muscle groups		
Hip flexors	Supine, hip and knee 90° flexed, ankle supported by examiner	Anterior surface of distal thigh
Knee flexors	Prone, knee flexed 45°	Heel
Knee extensors	Prone, knee 90° flexed	Anterior surface of distal limb just proximal to ankle joint

Table 2 Means of three strength measurements of the painful side compared with the nonpainful side (newton)

	Painful side Mean (SD)	Nonpainful side Mean (SD)	Differences Mean (SD)	95% CI of the difference	% ^a
Upper limb (n=13)					
Shoulder abduction	96 (71)	131 (69)	- 35 (36*)	- 56 to -13	73
Elbow extension	91 (82)	135 (72)	- 44 (51*)	- 75 to -13	68
Three-point grip	77 (54)	96 (32)	- 19 (32)	- 38 to 1	80
Lower limb (n = 27)					
Hip flexion	112 (67)	157 (66)	- 44 (41**)	- 60 to -28	72
Knee flexion	67 (54)	98 (58)	- 31 (31**)	- 43 to -19	68
Knee extension	129 (90)	169 (78)	- 40 (65*)	- 65 to -14	76

* $p < 0.01$; *** $p < 0.001$.
^aMuscle strength of the painful side as a percentage of the muscle strength of the nonpainful side.

Table 3 Correlation between muscle strength reduction of three motions of the upper limb and lower limb of the painful side

	Hip flexion	Knee flexion	Shoulder abduction	Elbow extension
Knee flexion	0.587*	-	0.882*	-
Knee extension	0.570*	0.724*	0.526#	0.717*

* $p > 0.01$; # $p = 0.065$.

Table 4 Relation between reductions in muscle strength, pain intensity and duration of pain

Reduction in muscle strength	Pain intensity	Duration of pain
Hip flexion	0.434 *	0.271
Knee flexion	0.476 *	0.250
Knee extension	0.551 *	0.050
Shoulder abduction	0.222	-0.154
Elbow extension	0.266	-0.236
Three-point grip	0.658*	-0.170

* $p < 0.05$.

in pain or fear the re-injury of painful structures.⁹ Fear of pain or fear of re-injury may explain why patients perform worse while testing the painful limb. Patients with chronic pain often avoid using the painful limb. This avoidance behaviour (disuse) may lead to physiological changes in the limb, such as atrophy. Avoidance may also lead to qualitative changes in muscle contraction such as abnormal co-ordination, resulting in ineffective contractions causing reduced muscle strength. No relation was found between duration of pain and

strength reduction, probably because the duration of pain in this group was extreme: 36 patients (90%) had experienced pain for one year or longer. It may be that duration of pain is of more influence in a group with a shorter history of pain with less behavioural changes. Because the influence of (chronic) pain on muscle strength reduction is considerable, muscle strength measurements in patients with pain should be interpreted with great care. When strength increases as an outcome of treatment, it must be considered what has caused this improvement.

Clinical messages

- If strength measurement is used in the assessment of patients with neurological deficits or for the outcome of rehabilitation studies, the influence of pain has to be considered.
- In chronic pain patients a reduction in muscle strength of 20–30% is ‘normal’.

Differences in mean muscle strength were not significant for three-point grip. Although pain was often perceived in a whole limb, some patient with upper limb pain did not perceive pain in the hand. The study was performed in a small group of patients with nonspecific pain. Although we measured, each muscle group three times, after a warm-up session, testing muscle strength on more than one occasion increases the reliability. The difference in muscle strength between the painful and nonpainful side may be attributed to a decrease in muscle strength on the painful side because of pain, avoidance behaviour or fear, but also to an increased use on the non-painful side.

We excluded patients with complex regional pain syndrome type I because we thought that muscle strength testing might aggravate their pain too much. From the study of Geertzen *et al.*, muscle strength reduction in complex regional pain syndrome type I patients seems similar to that in nonspecific chronic pain patients.⁶ Psychiatric disorders were excluded mainly to prevent patients with conversions from entering the study.

Several authors have produced normative values for isometric muscle strength measurements with hand-held dynamometry.^{5,10,11} Since no normative data have been published for patients with pain or nonspecific chronic pain, the differences in muscle strength between painful and nonpainful limbs found in this study can be used as a guide for muscle strength reduction in patients with long-term pain.

In conclusion, chronic pain is significantly related to muscle strength reduction. A reduction of 20–30% in a painful limb seems to be 'normal' in chronic pain patients.

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